DEMONSTRATION OF AN INTEGRATED APPROACH TO MERCURY CONTROL AT LEE STATION

Quarterly Report No. 4

March 27, 2006 – June 26, 2006

Prepared by:

Vitali Lissianski, Pete Maly, and Wei Zhou

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GE Energy

Energy and Environmental Research Corporation (GE EER)

1831 E. Carnegie Ave, Santa Anna, CA 92705

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Abstract

In this project General Electric Energy and Environmental Research Corporation (GE EER) conducts a field evaluation of a novel multi-pollutant control technology for coal-fired power plants that can reduce emissions of mercury (Hg) and oxides of nitrogen (NO_x) while simultaneously improving plant efficiency and reliability. The technology evaluation takes place in Lee Station Unit 3 located in Goldsboro, NC and operated by Progress Energy.

Activities during the current reporting period (March 27, 2006 – June 26, 2006) included pilot-scale testing of the effect of sorbent injection on mercury reduction and CFD modeling of sorbent injection and duct humidification. Evaluation of the effect of carbon-based sorbents injection on mercury reduction took place in 1 MBtu/hr (300 kW) Boiler Simulator Facility (BSF) equipped with an ESP. Testing has demonstrated that Darco Hg and Darco Hg-LH showed similar performances and that 70% mercury reduction from the baseline level can be achieved at sorbent injection rate of 10 lb/MMACF. A three-dimensional Computational Fluid Dynamics model was developed to study the flow distribution and sorbent injection in the post air heater duct in Lee Station Unit 3. Modeling has demonstrated that the flow is severely biased from the south side to the north side due to the bend of the duct. Based on results of the modeling, modifications in the design of humidification and sorbent injection system have been suggested and incorporated in the final systems design.

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Revision History

Revision	Date	Author(s)	Approver	Description of Changes
01	25 July 2006	Vitali Lissianski Pete Maly Wei Zhou	Randy Seeker	Release to U.S. DOE

Executive Summary

In this project General Electric Energy and Environmental Research Corporation (GE EER) conducts a field evaluation of a novel multi-pollutant control technology for coal-fired power plants that can reduce emissions of mercury (Hg) and oxides of nitrogen (NO_x) while simultaneously improving plant efficiency and reliability. The technology evaluation takes place in Lee Station Unit 3 located in Goldsboro, NC and operated by Progress Energy. Unit 3 burns a low-sulfur Eastern bituminous coal and is a 250 MW opposed-wall fired unit equipped with an ESP with a specific collection area (SCA) of 249 ft^2/kacfm. The technical goal of the project is to evaluate the technology's ability to achieve 70% Hg reduction below baseline emissions of 2.9 lb/TBtu.

Activities during the current reporting period (March 27, 2006 – June 26, 2006) included pilot-scale testing of the effect of sorbent injection on mercury reduction and CFD modeling of sorbent injection and duct humidification. Pilot-scale testing is designed to provide initial assessment of the performances of carbon-based sorbents Darco Hg and Darco Hg-LH with Lee coal and to estimate injection rate of the sorbent for long-term testing. CFD modeling was used to estimate droplet evaporation times for duct humidification system, activated carbon mixing pattern, and to provide guidelines for the design of water and sorbent injection lances.

Evaluation of the effect of carbon-based sorbents injection on mercury reduction took place in a 1 MBtu/hr (300 kW) Boiler Simulator Facility (BSF) equipped with an ESP. Testing has demonstrated that Darco Hg and Darco Hg-LH showed similar performances. Based on results of pilot-scale testing, it is expected that Darco Hg will be selected for long-term testing. Estimated sorbent injection rate required to achieve incremental 70% improvement in mercury reduction is 10 lb/MMACF. Final selection of sorbent and sorbent injection rate will be made after completion of full-scale sorbent optimization tests.

A three-dimensional CFD model was developed to study the flow distribution and sorbent injection in the post air heater duct in Lee Station Unit 3. Modeling of the flow pattern exiting the system air pre-heater has demonstrated that because of the duct transition from a circular opening at the exit of air-pre-heater to a rectangular ESP inlet duct, flow separation occurs at the corners after the transition. Modeling also has demonstrated that the flow is severely biased from the south side to the north side due to the bend of the duct. The flue gas temperature at the air pre-heater exit varies from 250 ^oF to 300 ^oF and the biased temperature

distribution is carried out through the duct with the degree of biasing being reduced by thermal diffusion and convection.

Modeling of water injection has demonstrated that 40 μm water droplets (average droplet size) evaporate within 500 milliseconds after the injection. Modeling showed that because of flue gas temperature biasing, the droplet evaporation rate is slower on the north side than that on the south side of the duct. Modeling suggested that more effective water evaporation could be achieved by closing the lance on the north side where flue gas temperatures were lower.

Modeling of sorbent injection has demonstrated that for the baseline design of the sorbent injection system the area between the lances does not have good sorbent coverage. Further analysis has demonstrated that the sorbent coverage between lances can be improved by increasing the transport-air flow rate. These changes were incorporated in the final design of the sorbent injection and humidification systems.

1.0 Introduction

The objective of this program is to conduct a field evaluation of a novel multi-pollutant control technology for coal-fired power plants that can reduce emissions of mercury (Hg) and oxides of nitrogen (NO_x) while simultaneously improving plant efficiency and reliability. The technology evaluation takes place in Lee Station Unit 3 located in Goldsboro, NC and operated by Progress Energy. Unit 3 burns a low-sulfur Eastern bituminous coal and is a 250 MW opposed-wall fired unit equipped with an ESP with a specific collection area (SCA) of 249 ft^2/kacfm.

The technical goal of the project is to evaluate the technology's ability to achieve 70% Hg reduction below baseline emissions of 2.9 lb/TBtu. The strategy to achieve the 70% incremental improvement in Hg removal in Unit 3 is (1) to enhance "naturally" occurring fly ash Hg capture by optimizing the combustion process and using duct humidification to reduce flue gas temperatures at the ESP inlet from current 280 ^oF to 250-260 ^oF, and (2) to use injection of small amounts of activated carbon (AC) in front of the ESP as an Hg removal polishing step.

Activities during the current reporting period (March 27, 2006 – June 26, 2006) included pilot-scale testing of the effect of sorbent injection on mercury reduction and CFD modeling of sorbent injection and duct humidification. Although CFD modeling is not part of the program scope of work, the decision was made to proceed with it and to use modeling results to optimize sorbent injection system. Once model is set up, it also can be used to optimize duct humidification system.

Pilot-scale testing is designed to provide initial assessment of the performances of carbon-based sorbents Darco Hg and Darco Hg-LH with Lee coal and to estimate injection rate of the sorbent for long-term testing. CFD modeling was used to estimate droplet evaporation times for duct humidification system, activated carbon mixing pattern, and to provide guidelines for the design of water and sorbent injection lances.

2.0 Summary of Project Activities During Previous Reporting Period

Activities during previous reporting period included optimization of Unit 3 air flow, burner tuning, and installation of ports for sorbent injection. Mercury capture on fly ash and NO_x reduction are expected to improve as a result of combustion optimization. The main factors that contribute to the increase in mercury capture are uniform distribution of high carbon fly ash across the ESP inlet duct and increase in LOI. Non-uniformity of coal and air flows to burners results in flue gas stratification. Balancing of the burner airflow is a fundamental and recognized step that helps to achieve optimum boiler performance. During the testing at Lee Station Unit 3, a 10-point grid was installed in the primary super-heater region of the back pass. The overall variation in O_2 measurements in the 10-point grid prior to air flow balancing was 23%. Through a series of adjustments to the burner air register disks, the variation in the point-to-point O_2 measurements was lowered to 15%

Additional improvement in the combustion process was achieved by adjusting the burner inner and outer vane setting. These adjustments resulted in reduction of NO_x emissions by ~16%.

3.0 Pilot-Scale Testing

Pilot-scale testing is designed to provide initial assessment of the sorbent selection and sorbent injection rate for full-scale testing. Evaluation of the effect of carbon-based sorbents injection on mercury reduction took place in a 1 MBtu/hr (300 kW) Boiler Simulator Facility (BSF) equipped with an ESP at the GE Energy Test Site in Santa Ana, CA. The BSF (Figure 1) is designed to simulate a coal-fired boiler. It consists of a burner, vertically down–fired radiant furnace, and horizontal convective pass. A variable-swirl diffusion burner with an axial fuel injector is used to simulate the approximate temperature and gas composition of a commercial burner in a full-scale boiler. Numerous ports located along the axis of the facility allow access for supplementary equipment such as OFA and additives injectors and sampling probes.

The BSF was configured by using cooling rods in the convective pass to match the residence time-temperature profile and furnace exit gas temperature typical for coal fired units. The BSF was fired on natural gas overnight and on coal during day.

The Electrostatic Precipitator (ESP) for the BSF is the plate type with three electric fields, each measuring 3 feet by 4.5 feet. An individual transformer rectifier is supplying power to each field. Each field contains two gas passages comprised of three parallel collecting panels. The gas passage width is defined at 4 inches. Specific Collection Area of ESP is 450 ft^2/1000 ACFM. Flue gas treatment time in ESP is about 10 seconds.

Data on mercury removal were obtained using US EPA Appendix K method also known as Quick CEM or carbon tube method. Frontier Geosciences analyzed sorbent traps for total mercury. Mercury data were collected at ESP outlet.

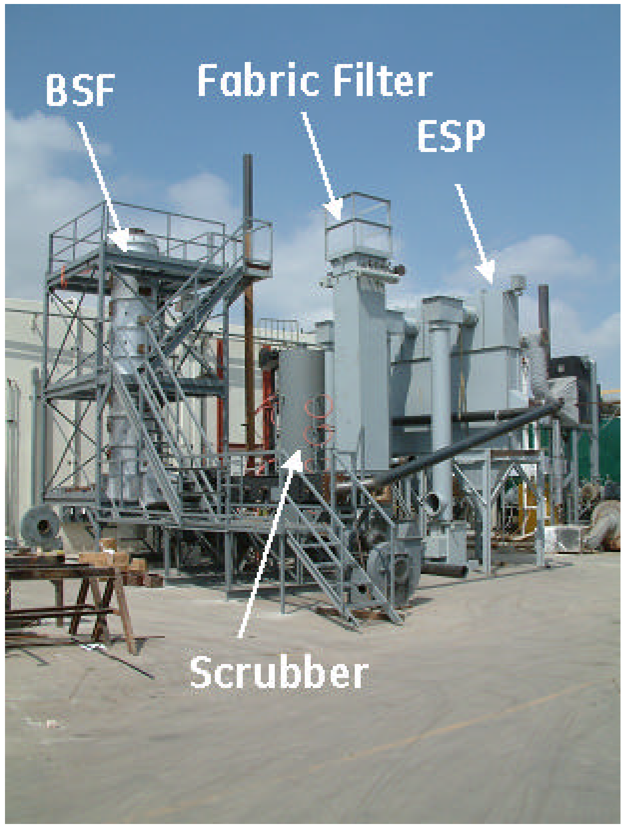

Figure 1. Boiler Simulator Facility (BSF).

The BSF was fired on Lee coal and sorbent was injected upstream of ESP. Lee coal is a low-sulfur bituminous coal, SO_2 emissions in pilot-scale tests were ~610 ppm @3%O_2. Chlorine content in Lee coal is 460 ppm. Two sorbents were tested: Darco Hg and Darco Hg-LH. Since baseline mercury testing[1] has demonstrated that the percentage of oxidized mercury in flue gas was ~80%, it was expected that two sorbent would show similar performances.

Figure 2 shows effect of sorbent injection on mercury reduction. Mercury reduction was calculated as a reduction from the baseline mercury concentration at ESP outlet due to sorbent injection only. For comparison, data on Darco Hg performance obtained during full-scale testing[2] at Brayton Point are also shown. In general, pilot- and full-scale data are in good agreement although pilot-scale testing showed slightly better Darco Hg performance. This is not surprising

1. "Demonstration of an Integrated Approach to mercury Control at Lee Station". First Quarterly Report, DOE Contract No. DE-FC26-05NT42310, January 2006.
2. Feeley, T.J. III., Murphy, J., Hoffmann J., and Renninger, S.A.. "A Review of DOE/NETL's Mercury Control Technology R&D Program for Coal-Fired Power Plants". *DOE/NETL Hg R&D Program Review, April 2003.*

since typically pilot-scale testing provides more uniforms flow of flue gas and better sorbent mixing.

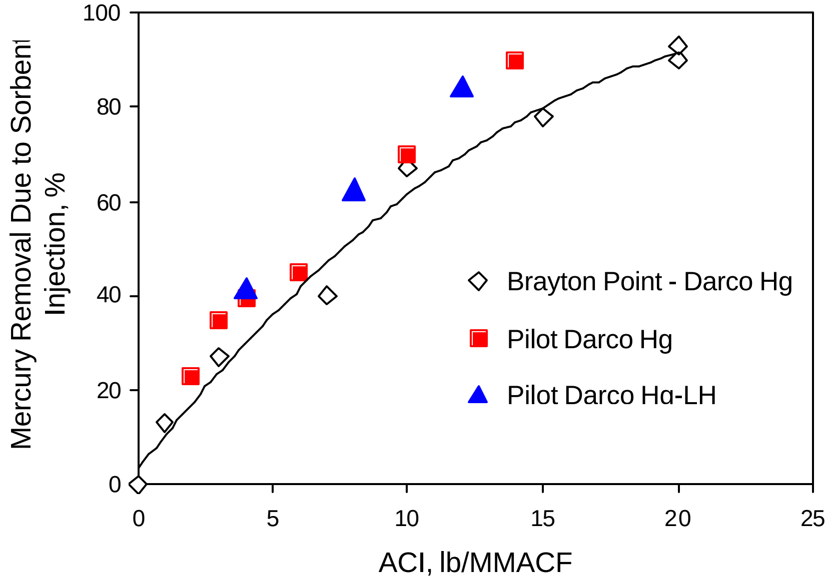

Figure 2. Effect of sorbent injection on mercury removal. Diamonds and line represent Brayton Point data.

Two main conclusions can be derived from Figure 2. First, Darco Hg and Darco Hg-LH showed similar performances. For the last several years a number of carbon-based sorbents were evaluated[3,4,5,6] in pilot- and full-scale test programs. These tests have determined that different sorbents deliver different performance. However, tests also demonstrated that halogen impregnated sorbents such as B-PAC by Sorbent Technologies, Inc. and Darco Hg-LH by Norit Americas delivered superior performance (both regarding to mercury removal efficiency and overall cost of mercury control) to other sorbents for low-rank coal combustion. This is because bromine present in promoted sorbents oxidizes elemental mercury and thus approves ability of activated carbon to remove mercury. Since flue gas generated during combustion of Lee coal already has about 80% of mercury present in the oxidized form, promoted sorbents do not offer

3. Thompson et al. "Sorbent Injection into a slipstream baghouse for mercury Control: Screening and parametric Results", Presented at Air Quality V, September 2005.
4. Dombrowski et al. " Full-Scale Activated Carbon Injection for mercury Control in Flue Gas Derived from North Dakota Lignite and PRB Coal", Presented at Air Quality V, September 2005.
5. Sjostrom et al. "Full-Scale Evaluation of Mercury Control by Injecting Activated Carbon Upstream of a Spray Dryer and Fabric Filter", Presented at Combined Power Plant Air Pollutant Control Mega Symposium, Paper 71, August-September 2004.

additional performance advantage in comparison with the baseline sorbent. Pilot-scale testing confirmed this observation. Although Darco Hg and Darco Hg-LH will be tested during sorbent optimization tests prior to long-term testing, GE expects that Darco Hg will be selected for long-term testing. Based on results of pilot-scale testing, sorbent injection rate required to achieve incremental 70% mercury reduction is 10 lb/MMACF.

4.0 CFD Modeling

Effective mercury removal using sorbent injection is possible only when sorbent is uniformly distributed across duct cross-section allowing better utilization of mercury removal capacity of the sorbent. Recent results[7] of Computational Fluid Dynamics (CFD) modeling of sorbent injection suggest that relatively low mercury removal efficiencies due to sorbent injection observed at least in some full-scale tests were due to poor sorbent mixing with flue gas. Poor mixing may be result of bad design of sorbent injection lances or due to flue gas flow distribution

Following sections describe model setup and modeling results of water and sorbent injection upstream of ESP.

4.1 CFD Model Setup

A three-dimensional CFD model was developed to study the flow distribution and sorbent injection in the post air heater duct in Lee Station Unit 3. There are two ducts exiting out of the air heater and entering the ESP. The two ducts are independent and geometrically symmetrical and therefore, the CFD model was developed for one side of the duct where sorbent would be injected. The CFD model geometry is shown in Figure 3. The model inlet is at the outlet of the air heater. A set of turning vanes sits in the 90-degree elbow to help distribute the flow and minimize the flow separation. Thirteen baffles are located at the 90 degrees turn before the ESP, along with the perforated plate to eliminate the reverse flow from the ESP.

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6. Pavlish, et al. “Pilot-Scale Testing of Sorbent Injection and Fuel Additives for Mercury Control” Presented at Combined Power Plant Air Pollutant Control Mega Symposium, Paper 108, August-September 2004.
7. J. Madsen and A. Diamant. “CFD Modeling of Full-Scale Sorbent Injection for Mercury Control – Lessons Learned from DOE/NETL Field Test Program”. Presented at 7th EUEC Conference, January 2006.

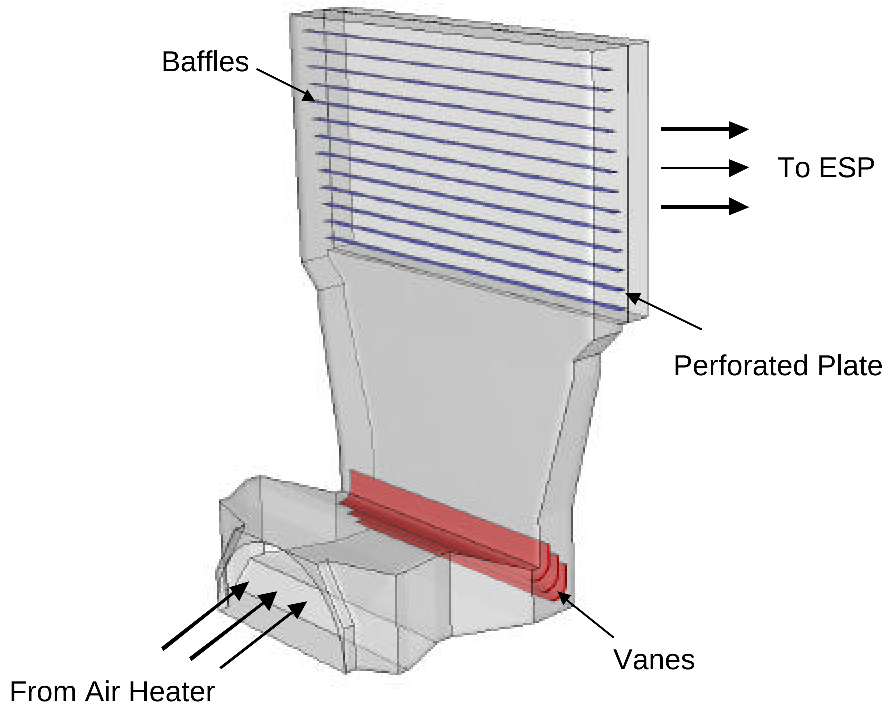

Figure 3. Duct geometry for CFD modeling.

Fluent solves transport equations, such as continuity, momentum and energy equations, to simulate the flow and temperature distributions in the duct. Physical models such as turbulence model, discrete phase model, and droplet-evaporation model are applied to account for sorbent particle mixing and water droplet evaporation processes in the turbulent duct flow.

Appropriate boundary conditions are required for enclosure of the transport equations. The boundary conditions include the flow rates at model inlets, initial particle/droplet size and its distribution and pressure resistance of the perforated plate. The outputs from the CFD model are velocity vectors, temperature information and particle/droplet concentration at the center of each computational cell. The information can be used to plot the velocity, temperature and particle/droplet concentration profiles in the three-dimensional domain.

4.2 CFD Modeling Approach and Boundary Conditions

The CFD modeling studies followed three steps: 1) baseline study, 2) humidification system study, and 3) sorbent injection study. The baseline study provides an understanding on the flow and temperature distributions without water and sorbent injection. The humidification system study evaluates the completeness and uniformity of water droplet evaporation before the

ESP. Finally, the sorbent injection study is performed to predict the sorbent particle trajectories and the mixing performance of the sorbent injection system. The discrete phase model is applied to the last two studies to simulate the particle or droplet trajectories and the mass and heat transfer between the continuous phase and the discrete phase.

The boundary conditions for the three studied cases are summarized in Table 4. The flow rates in Table 1 are for the single duct at 263 MW load condition. Flue gas temperature at the model inlet is around 300 ^{o}F and is biased from side to side as shown in Figure 4. The biased profile is extracted from field measurements taken by the plant downstream of the turning vanes.

Table 1. CFD model inputs.

One Duct	Unit	Values
Flue Gas Flow Rate	lb/hr	1,410,815
Flue Gas Temperature	degrees F	300
Sorbent Injection		
Transport Air Flow Rate	lb/hr	6,550
Sorbent Flow Rate	lb/hr	400
Transport Air Temperature	degrees F	120
Humidification		
Water	GPM	12
Water Temperature	degrees F	80
Transport Air	SCFM	325
Injection Full Angle	degrees F	25

The humidification system is designed to have four lances per duct. The spacing of the lances is shown in Figure 5. The baseline design for humidification lances included three nozzles of 5.5 mm diameter in each lance. The water droplet injections was modeled as point injections without transport air to simplify the model geometry. The droplets were injected upward in a conical shape from the specified injection locations at a full angle of 25^{o} which corresponded to the nozzle design as specified by the vendor. It was assumed that the droplet size followed Rosin-Rammler distribution as shown in Figure 6. When the droplets impinge on the baffles, it is assumed that the droplets are dispersed and are trapped onto the baffles.

The initial (baseline) design of the sorbent injection system consists of four lances per duct, each of which has eight (8) holes as shown in Figure 7. To resolve the flow field surrounding the small holes, a fine mesh was created near the lances and therefore, the model is truncated after the turning vanes to reduce the number of cells and computational time. The transport air and the sorbent flow rates are listed in Table 1. The sorbent particle size and its distribution used in the model are shown in Figure 8. It was assumed that the distribution followed Rosin-Rammler distribution and is derived based on the mean particle size (18 µm) and 95% particles greater than 45-micron size as specified in the Darco Hg MSDS.

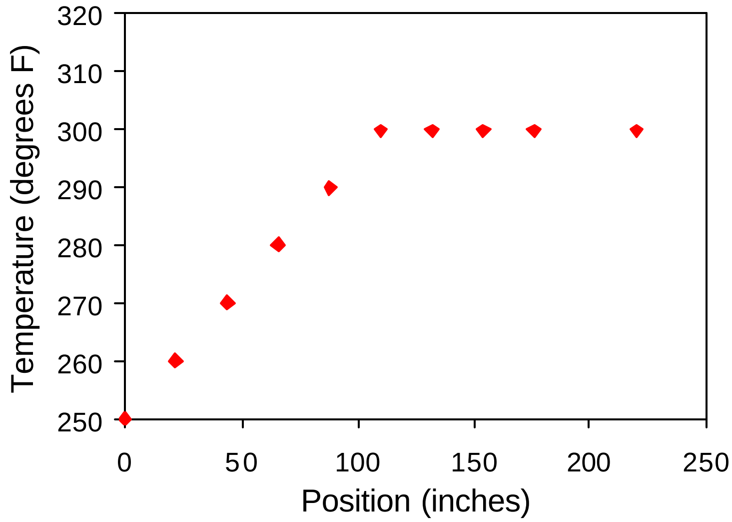

Figure 4. Temperature distribution across ESP inlet duct.

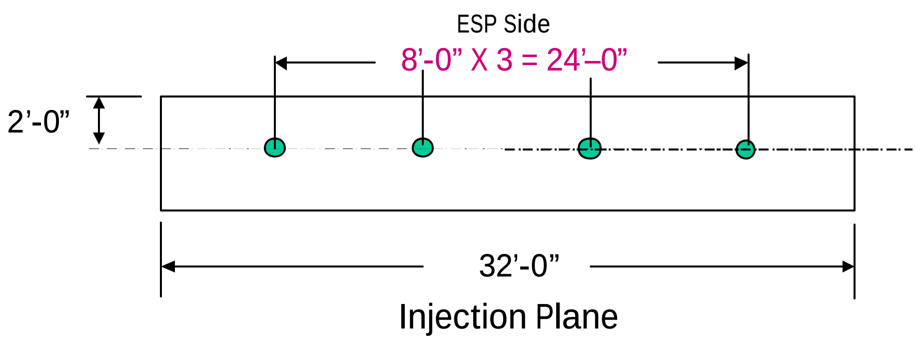

Figure 5. Lance layout for the humidification system

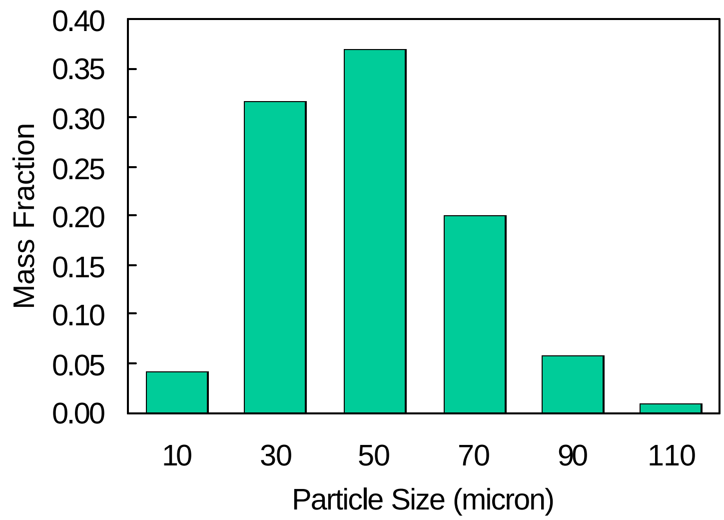

Figure 6. Water droplet size distribution.

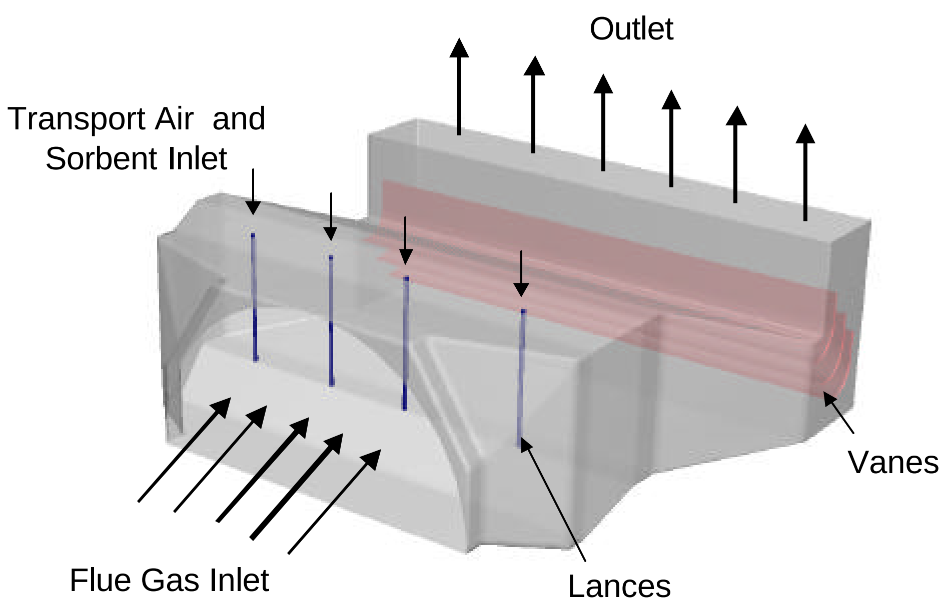

Figure 7. Sorbent injection model.

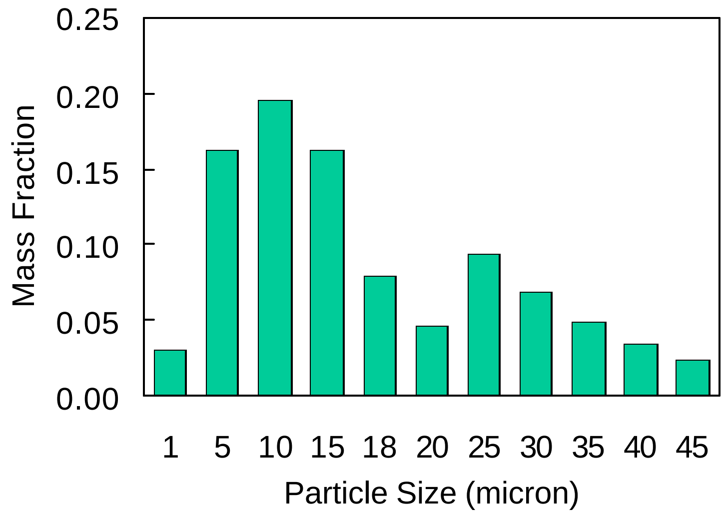

Figure 8. Sorbent particle size distribution.

The CFD results for baseline, humidification and sorbent injection studies are presented and discussed below.

4.3 Baseline Study

The baseline case represents duct conditions before injection of sorbent and water droplets to lower flue gas temperature. The flow distribution at the model inlet is assumed to be uniform coming out of the air heater. The temperature profile at the model inlet, however, is biased and is specified based on the distribution shown in Figure 4.

Figure 9 shows the velocity profiles at the cross sectional planes along the duct. Since the duct transits from a circular opening to a rectangular one, flow separation occurs at the corners after the transition, which results in reverse flow in the local area. Before the elbow, the flow is severely biased from the south side to the north side due to the bend of the duct. The biased flow distribution hints that the sorbent flow distribution amongst the four lances should be biased as well to follow the flue gas flow distribution. The turning vanes at the elbow have helped to distribute the flow from front to back. However, the flow is still biased slightly in this direction.

Temperature profiles in the duct are shown in Figure 10. The temperature varies from 250 ^{o}F to 300 ^{o}F at inlet based on the measurements. The biased distribution is carried out through the duct with the degree of biasing being reduced by thermal diffusion and convection. Average temperature of each cross sectional plane along the duct is about 287.5 ^{o}F.

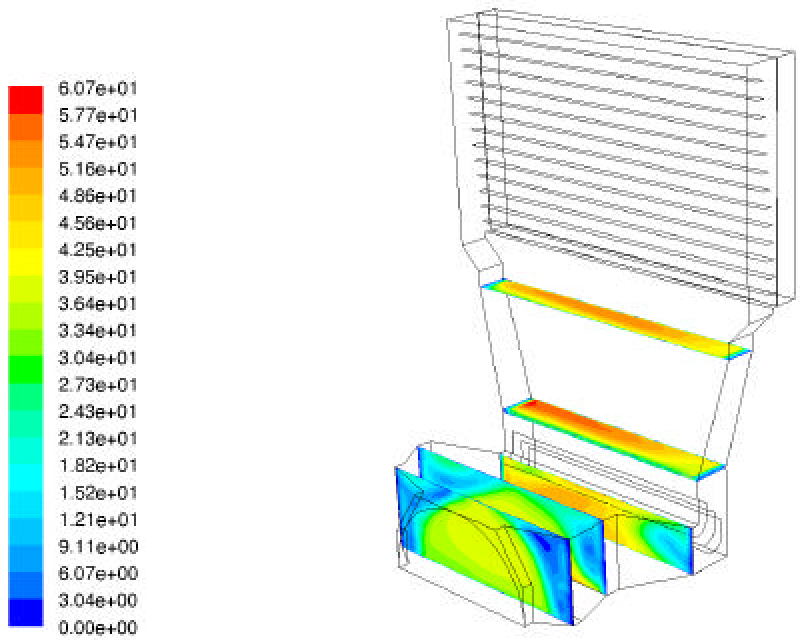

Figure 9. Baseline velocity profiles in the duct.

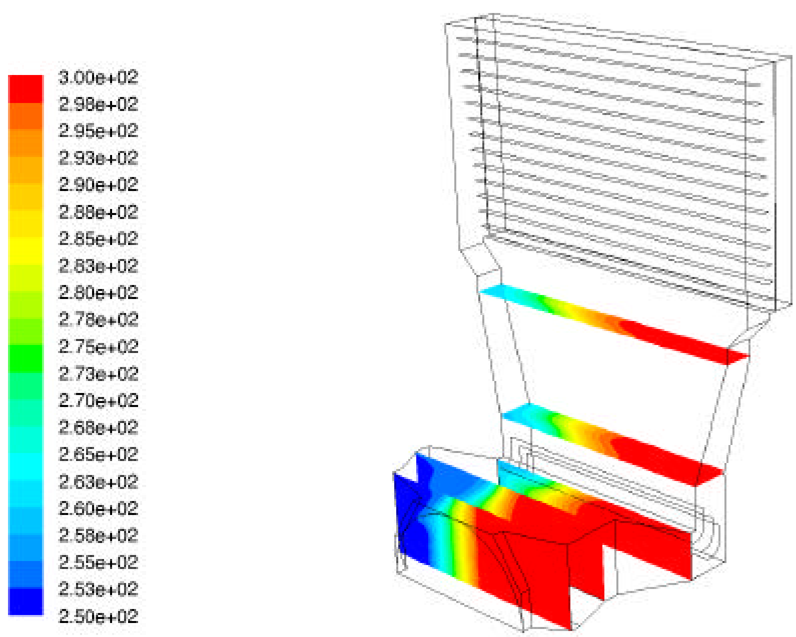

Figure 10. Temperature profiles in the duct.

4.4 Humidification Study

As shown in Figure 11, water droplets are sprayed upward from four lances that are spaced out evenly. Each lance has three small nozzles with 25 degrees spray angle. The trajectories of the water droplets in Figure 11 are colored by residence time. It takes about 500 milliseconds for the droplets to travel from the nozzles to the upfront of the baffles.

Figure 12 shows the water droplet concentrations. The concentrations of water droplets have a discrete distribution and the discrete distribution is carried out through the rest of the duct. At the model exit, i.e., the entrance of ESP, more than 80% (mass weighted) droplets are evaporated and less than 20% droplets escape to ESP, most of which escape from the north side of the duct as shown in Figure 12. The biased water-droplet escaping rate is due to the imbalanced temperature distribution in the duct. The flue gas temperature in the duct is lower on the north side as shown in Figure 13. As a result, the droplet evaporation rate is slower on the north side than that on the south side.

To reduce the amount of water droplets escaping to ESP, the water flow rate to lances can be adjusted. One study has been done to evaluate the improvement of water droplet evaporation by closing the lance on the north most side. The result indicates that the amount of evaporated droplets increases from 80% to 85%.

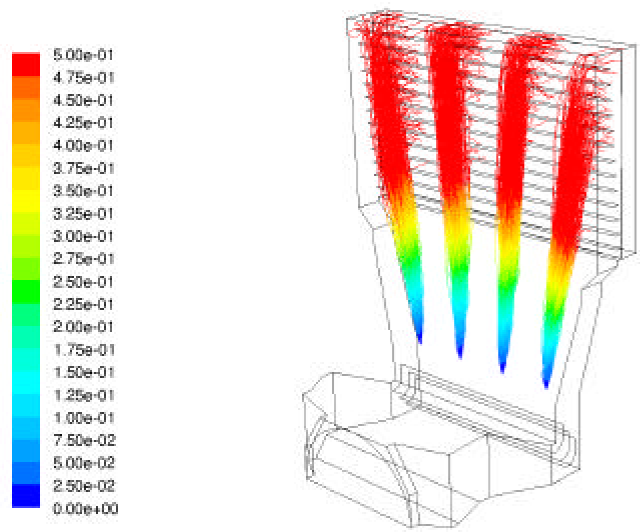

Figure 11. Water droplets trajectories colored by residence time.

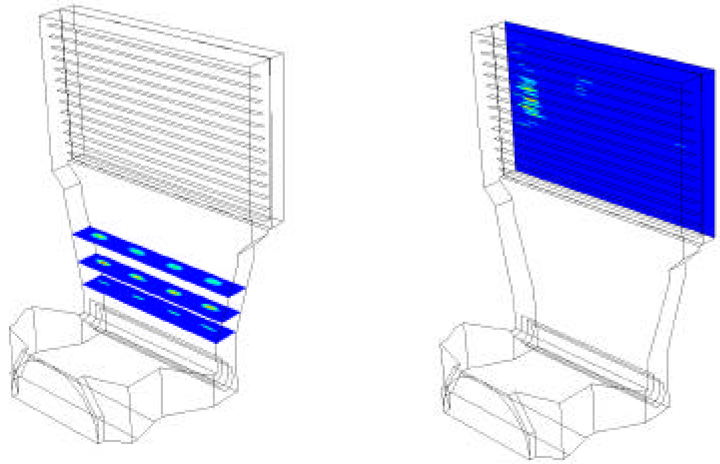

Figure 12. Water droplet concentration.

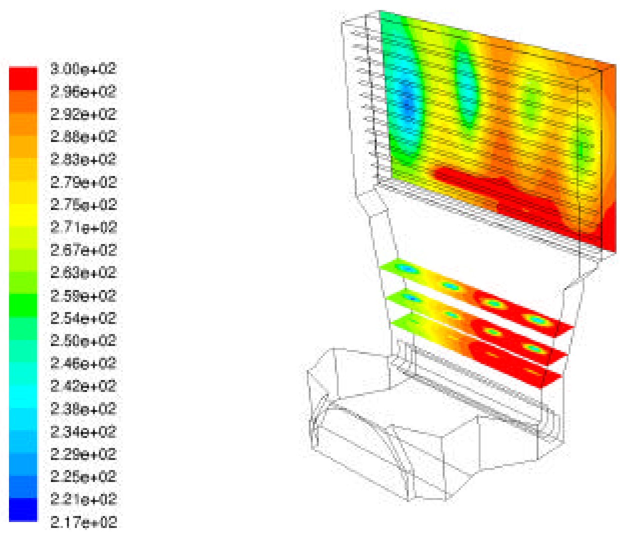

Figure 13. Temperature profiles in the duct.

4.4 Sorbent Injection Study

Four sorbent injection lances are placed unevenly across the duct. Sorbent is pre-mixed with transport-air and enters the computational domain at the top of each lance. Sorbent and transport air then leave the lances at a high speed and in an alternate pattern to produce a good mixing between sorbent and flue gas as shown in Figure 14.

The distributions of sorbent concentration, however, are discrete based on CFD predictions as shown in Figure 15. Both temperature profiles (Figure 15) and the sorbent concentration profiles indicate that the area between the lances is lack of sorbent coverage. The lack of coverage increases between the two lances located at south side where the spacing between the lances is wider.

Figure 16 shows the sorbent trajectories in the duct. The sorbent does not penetrate far enough into the flue gas. The particles are carried along with the flue gas at a close distance from the holes. Further studies have demonstrated that the sorbent coverage between lances can be improved by increasing the transport-air flow rate and therefore, the momentum of the transport air.

Figure 16 also indicate that the sorbent injected near corners may enter the recirculation zone that is produced by the transition from the circular duct to the rectangular duct. The sorbent that is brought into the recirculation zone may enter the air heater. Reducing the sorbent flow rate near north corners may help to solve this problem.

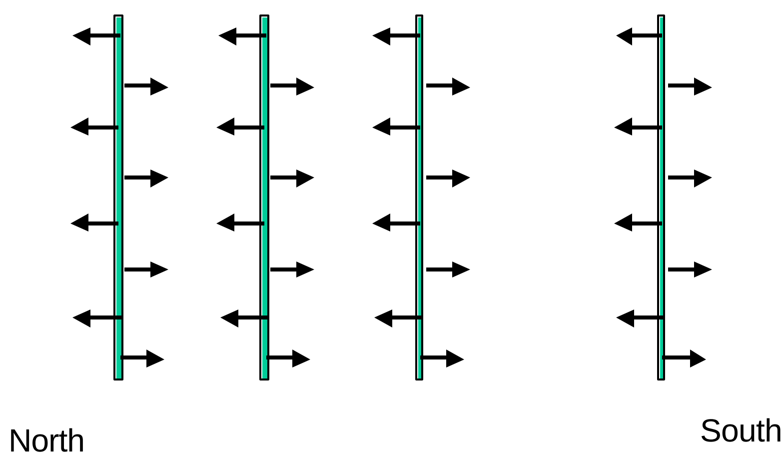

Figure 14. Sorbent particle concentrations.

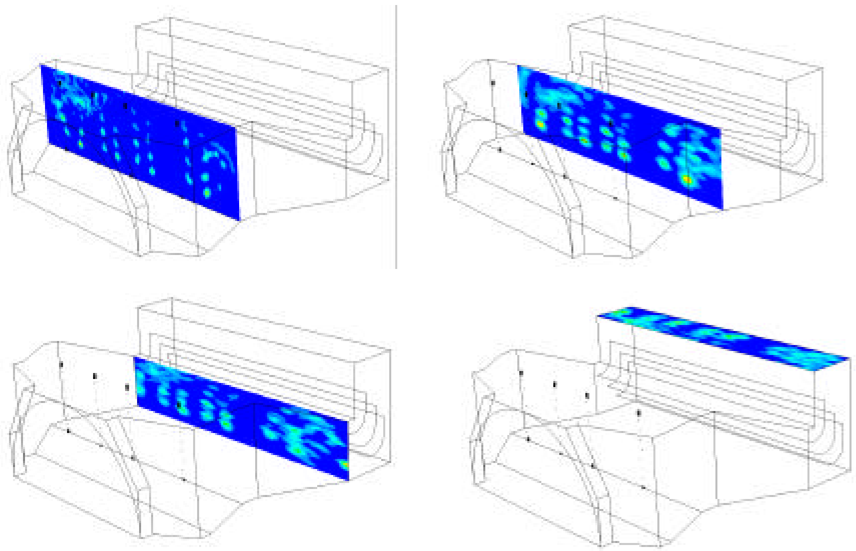

Figure 15. Sorbent particle concentrations.

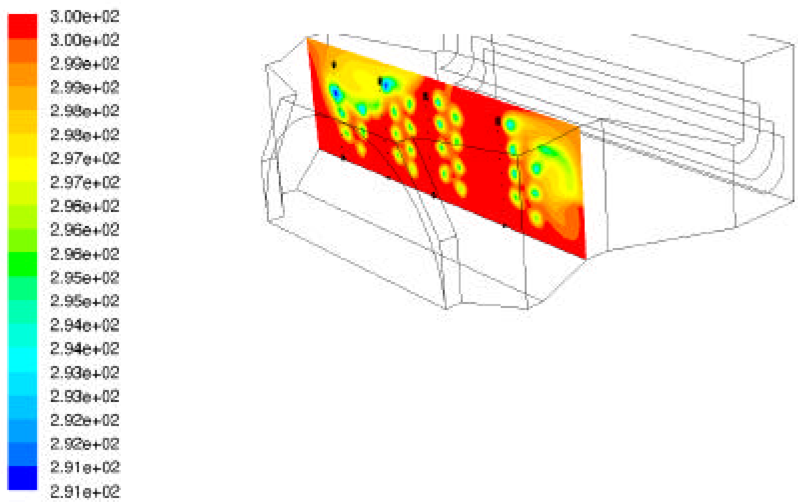

Figure 16. Temperature distribution (^{o}F).

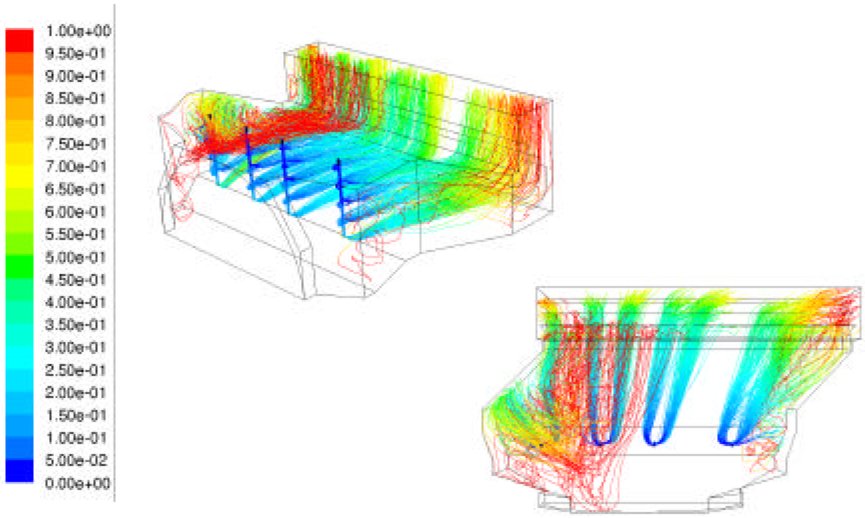

Figure 17. Sorbent trajectories colored by residence time (s).

5.0 Preparation for Sorbent Injection Tests

Table 2 shows schedule of the program activities leading to long-term sorbent testing.

Pilot-scale testing and CFD modeling designed to provide information on the design of sorbent injection and humidification system, preliminary sorbent selection for testing, and sorbent injection rate, have been completed. Fabrication of sorbent injection and humidification systems have also been completed. Both systems have been delivered on site. Table 2 also presents details on installation of these system which will be completed by July 24. Sorbent evaluation tests are scheduled to start during the last week of July and long-term mercury testing will start in August.

6.0 Summary

Activities during the current reporting period (March 27, 2006 – June 26, 2006) included pilot-scale testing of the effect of sorbent injection on mercury reduction and CFD modeling of sorbent injection and duct humidification. Pilot-scale testing is designed to provide initial assessment of the performances of carbon-based sorbents Darco Hg and Darco Hg-LH with Lee coal and to estimate injection rate of the sorbent for long-term testing. CFD modeling was used to estimate droplet evaporation times for duct humidification system, sorbent mixing pattern, and to provide guidelines for the design of water and sorbent injection lances.

Table 2. Schedule of program activities.

Action Item	Start Date	End date	Work days	PE Support	April	May	June	July	August	September
					1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4 5	1 2 3 4
1. Mercury testing										
1.1 Baseline mercury testing	6/5/06	5/12/06	1							
1.2 Bringing Unit 3 to optimized conditions	6/5/06	6/11/06	6							
1.3 Mercury testing at optimized conditions	6/12/06	6/16/06	1							
2. CFD modeling										
2.1 Data collection	4/10/06	5/12/06	15							
2.2 Modeling	5/15/06	6/2/06	15							
3. Pilot-scale testing										
3.1 Test matrix development	4/17/06	4/21/06	5							
3.2 PE review of test matrix	4/24/06	4/28/06	5							
3.3 Testing	5/1/06	6/2/06	25							
4. Sorbent Injection system										
4.1 Site visit with Nol-Tec to finalize system requirements	4/24/06	4/28/06	1							
4.2 Design review meeting with PE	5/22/06	5/26/06	1							
4.3 System fabrication	4/3/06	6/1/06	12 wks							
4.4 Communicating installation plan to PE	4/24/06	4/28/06	1							
4.5 GE/PE meeting to finalize installation requirements	5/29/06	6/2/06	1							
4.6 Estimate of installation costs	6/12/06	6/16/06	5							
4.7 System shipment to Lee station	7/10/06	7/16/06	5							
4.8 System installation	7/17/06	7/23/06	6							
4.9 System start up	7/24/06	7/30/06	6							
5. Humidification system										
5.1 Installation of ports	5/19/06	5/22/06	3							
5.2 Decision on air compressor rental	5/29/06	6/2/06	1							
5.3 Design review with PE	5/8/06	5/12/06	1							
5.4 System fabrication	4/3/06	6/1/06	12 wks							
5.5 Communicate installation plan to PE	5/15/06	5/19/06	1							
5.6 GE/PE meeting to finalize installation requirements	5/29/06	6/2/06	1							
5.7 Estimate of installation costs	6/12/06	6/16/06	5							
5.8 System shipment to Lee station	6/26/06	6/30/06	5							
5.9 System installation	7/10/06	7/16/06	6							
5.10 System start up	7/17/06	7/23/06	6							
6. Equipment installation details										
6.1 Concrete pad	7/10/06	7/12/06	2	Logistical						
6.2 Office trailer arrival	7/13/06	7/14/06	2	Provide 110 Volt Connection						
6.3 Humidification System Installation	7/10/06	7/14/06	4	Logistical						
6.4 Panel Wiring, 460 Volt	7/10/06	7/14/06	4	Electrician						
6.5 Load Following Signal, 4-20 mA	7/13/06	7/14/06	2	Controls/Electrician						
6.6 Compressor Arrival	7/13/06	7/14/06	2	Logistical						
6.7 Water Tie-In	7/13/06	7/14/06	2	none						
6.8 Scaffolding Installation/Rental	7/10/06	7/14/06	4	Logistical						
6.9 Sorbent System Installation	7/17/06	7/21/06	4	Logistical						
6.10 Silo/Bulk Bag Unloader, Dust Collector, Control Panel	7/6/06	7/14/06	8	Logistical						
6.11 Panel Wiring, 460 Volt	7/20/06	7/21/06	2	Electrician						
6.12 Load Following Signal, 4-20 mA	7/20/06	7/21/06	2	Controls/Electrician						
6.12 Mercury CEM deliver	7/10/06	7/28/06	5	none						
6. 14 Sorbent delivery	7/20/06	7/20/06	1	none						
7. Sorbent testing										
7.1 Sorbent optimization testing	7/24/06	7/29/06	6							
7.2 Long term sorbent testing	8/7/06	9/5/06	30							
7.3 Equipment removal	9/11/06	9/22/06	10							
8. GE team schedule										
8.1 Equipment installation team arrival on site (1 engineer and 1 tech)	7/6/06	7/14/06	10							
8.2 Mercury CEM contractor arrives on site	7/17/06	7/21/06	5	Electrician						
8.3 Mercury testing team arrives on site (1 engineer and 2 tech)	7/24/06	7/29/06	6							
8.4 Mercury testing	8/7/06	9/5/06	30	Sorbent system night watch						
8.5 Equipment removal team on site	9/11/06	9/22/06	10							
GE / Progress Energy meetings										

Scheduled or in progress
Completed

Evaluation of the effect of carbon-based sorbents injection on mercury reduction took place in 1 MBtu/hr (300 kW) Boiler Simulator Facility (BSF) equipped with an ESP. Testing has demonstrated that Darco Hg and Darco Hg-LH showed similar performances. Based on results of pilot-scale testing, it is expected that Darco Hg will be selected for long-term testing. Final sorbent selection will be made after completion of full-scale sorbent optimization tests. Sorbent injection rate required to achieve the 70% incremental improvement in mercury reduction is estimated at 10 lb/MMACF.

A three-dimensional CFD model was developed to study the flow distribution and sorbent injection in the post air heater duct in Lee Station Unit 3. Modeling of flow pattern exiting air pre-heater has demonstrated that because of the duct transition from a circular opening at the exit of air-pre-heater to a rectangular ESP inlet duct, flow separation occurs at the corners after the transition. Modeling also has demonstrated that the flow is severely biased from the south side to the north side due to the bend of the duct. The flue gas temperature at the air pre-heater exit varies from 250 ^oF to 300 ^oF and the biased temperature distribution is carried out through the duct with the degree of biasing being reduced by thermal diffusion and convection.

Modeling of water injection has demonstrated that 40 μm water droplets (average droplet size) evaporated within 500 milliseconds after the injection. Modeling showed that because of flue gas temperature biasing, the droplet evaporation rate is slower on the north side than that on the south side of the duct. Modeling suggested that an improvement of water droplet evaporation could be achieved by closing the lance on the north side where flue gas temperatures were lower.

Modeling of sorbent injection has demonstrated that for the baseline design of sorbent injection lances and sorbent transport air the area between the lances does not have good sorbent coverage. Further analysis has demonstrated that the sorbent coverage between lances can be improved by increasing the transport-air flow rate.